

REVISED EXECUTIVE SUMMARY

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TOTAL COST ASSESSMENT:

**ACCELERATING INDUSTRIAL POLLUTION PREVENTION
THROUGH INNOVATIVE PROJECT FINANCIAL ANALYSIS**

With Applications to the Pulp and Paper Industry

Prepared for:

**U.S. Environmental Agency
Office of Policy Planning and Evaluation
Office of Pollution Prevention**

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PREFACE

This Executive Summary supercedes a version originally published in a December 1991 report to EPA entitled: **Total Cost Assessment: Accelerating Pollution Prevention Through Innovative Project Financial Analysis, With Applications to the Pulp and Paper Industry.** This revised version includes changes to the text for purposes of clarification and completeness, as well as new results of the financial analysis of two pollution prevention projects in the pulp and paper industry. The latter changes reflect both refinements to the analytical tool used in the original profitability analysis and the availability of new data on the costs and savings of the projects themselves.

In the case of Project 1, a white water and fiber reuse project in a coated/fine paper mill, the revised analysis substantially strengthens the Total Cost Assessment in relation to the Company analysis using three indicators of profitability. The revised analysis shows an increase in Net Present Value (NPV, 15 years) from approximately \$360,300 to \$2,851,900; Internal Rate of Return (IRR, 15 years) increases from 21% to 48%; and Simple Payback decreases from 4.2 years to 1.6 years. In contrast, the revised analysis for Project No. 2, shows a TCA analysis less profitable than the Company analysis, largely owing to substantial increases in utility costs for operating an aqueous-based coating process. NPV decreases from approximately -\$203,600 to -\$395,600; IRR decreases from 11% to 6%; and Simple Payback increases from 7.6 to 11.7 years.

Taken together, the two revised analyses reinforce the central finding of the original study -- that improved managerial accounting systems, including accurate measurement and allocation of both physical and cost aspects of waste generation, are essential for achieving a clear, unbiased perspective on the profitability of industrial pollution prevention investments.

BACKGROUND

In its February 1991 *National Pollution Prevention Strategy*, EPA set in motion a series of initiatives aimed at deepening and widening both government and private sector activities in pollution prevention. Recognizing the inherent limitations of traditional "end-of-pipe" approaches, the Strategy called for joint agency-industry action to redirect resources toward elimination of pollutants instead of continued reliance on downstream, control-oriented approaches that, while effective in solving one pollution problem, often create others. Without a transition from control to prevention strategies, cross-media shifting of pollution among land, water and air will continue, and reduction of pollution from dispersed, non-point sources will remain extremely difficult to achieve.

For many firms, EPA's call for accelerated prevention served as a reaffirmation of what they already knew and, to varying degrees, practiced--that in the medium and long-term, pollution prevention generally is more sensible than pollution control. Early initiatives,

beginning in the 1970's, were motivated by a simple bottom-line consideration: continued expenditures on pollution control investments to handle steadily increasing waste volumes presented firms with the specter of an endless capital drain that would divert resources from more lucrative opportunities in R&D, product development, manufacturing and marketing.

By the mid 1980s, other forces were encouraging the shift to prevention-oriented strategies, including liability under the federal Superfund Act, public concerns with environmental degradation, increasingly stringent pollution disclosure requirements, and widely publicized industrial accidents in both the U.S. and abroad. As a result, firms have faced a rising tide of public demands for shifts to clean technologies and environmentally friendly products.

Notwithstanding pressures from various quarters, and the noteworthy progress of a few, typically large firms, manufacturers have been slow to move away from traditional end-of-pipe strategies toward more prevention-oriented practices. If, as many argue, pollution prevention pays, what accounts for this slow pace of change? If prevention investments are, in fact, in the self-interest of the firm, what accounts for the continuing reluctance to move aggressively toward a more preventative pollution management mode? And why, in light of the publicized benefits of pollution prevention, do firms, even large sophisticated ones, continue to be surprised when prevention-oriented projects produce advantages to the firm far beyond those expected of many conventional "must-do," compliance-driven capital investments?

The explanation for this apparent contradiction seems to be two-fold: (1) the organizational structure and behavior of firms inhibits pollution prevention projects from entering their decision-making process from the outset, thereby precluding these alternatives from consideration by the firm altogether; and (2) economic/financial barriers linked to methods of capital allocation and budgeting after a pollution prevention project successfully enters the capital budgeting process and competes with other projects for limited capital resources. A priori, it appears that both these factors, acting in concert, contribute to the sluggish pace of investment in industrial pollution prevention.

Economic/financial barriers, the second of the explanations we propose, is the focus of this study. Within a capital budgeting framework, we examine if, and to what extent, conventional methods of investment analysis act to impede pollution prevention projects in favor of end-of-pipe alternatives. Two projects actively under consideration by firms in the pulp and paper sector serve to demonstrate how different definition, measurement, and allocation of project costs/savings, longer time horizons, and the use of multiple profitability indices may remove the biases inherent in conventional financial methods.

THE PULP AND PAPER SECTOR

As a major source of industrial pollution, the pulp and paper sector provides a useful context for examining these alternative methods. Historically, environmental regulation of the

industry has focused on reduction of BOD and TSS in water effluent, and particulates, sulfur dioxide and organic sulfur compounds in air. Reductions of these pollutants have been achieved principally through end-of-pipe controls. Nonetheless, pollution prevention is by no means a new concept to pulp and paper firms. In-plant recovery and reuse of pulping chemicals, for example, is an integral part of the kraft pulping process. Other preventive measures include: in-plant fiber and water recovery and reuse in the paper mill, counter-current washing in the pulp mill, and dry wood debarking in the woodroom. These technologies have been widely implemented to reduce pollution generation and to reduce raw material and energy costs. Current environmental regulation of toxic air and water pollutants, toxic constituents in mill sludge, and pulp mill effluent standards for foam, odor, and color are posing new challenges to pulp and paper firms. Meeting many of these regulations will require materials and process changes rather than traditional end-of-pipe controls. Dioxin reduction, for example, requires process changes targeted at reducing dioxin formation, such as decreased use of chlorine in bleaching or oxygen delignification.

In a compliance context, a mill's choice between an end-of-pipe or a prevention strategy will depend heavily on the comparative economics of these options. This is so even in instances where profitability is negative, that is, when the firm expects a net loss on its investment. Unlike most end-of-pipe technologies, pollution prevention projects tend to reduce operating costs by reducing waste generation, regulatory activities, and pollution related liabilities. In addition, investments in pollution prevention may increase revenue by improving product or corporate image. Including these indirect or less tangible savings in the financial analysis of projects may enhance the estimated profitability of the prevention strategy, and may be decisive in selecting a pollution prevention versus an end-of-pipe option. It is at this decision point that the concepts and methods of **Total Cost Assessment (TCA)** -- the comprehensive, long-term financial analysis of pollution prevention projects -- can play a role in improving the financial picture of a pollution prevention investment, and enhance its competitiveness vis a vis pollution control projects. TCA techniques can also improve the projected financial performance of discretionary pollution prevention projects, thereby increasing their ability to compete for limited capital resources.

CASE STUDIES

To assess how TCA works in practice, we worked in close collaboration with the staff of two mills to analyze the economics of two pollution prevention projects. The first (Project 1) is a white water and fiber reuse project at a coated fine paper mill. This investment would permit fiber, filler, and water reuse on two paper machines at all times, thereby conserving raw materials and reducing water use, wastewater generation, and energy use for fresh and waste water pumping and freshwater heating. The second (Project 2) is a conversion from solvent/heavy metal paper coating to aqueous/heavy metal-free coating at a paper coating mill. This investment would substantially reduce solvent and heavy-metal usage, VOC emissions, and hazardous waste generation, while increasing water, steam, and electricity usage and increasing wastewater generation. For both projects, we developed a "company analysis" comprising costs typically used by the firms. We compared these to "TCA analyses" of the

same project, in which a full accounting of less tangible, longer term, and indirect costs and savings was made. To do this, we developed a spreadsheet system called P2/FINANCE to collect and organize capital and operating cost data, to calculate cash flows and financial indices, and to perform sensitivity analyses of the case studies.

COST INVENTORY

While cost categories considered in a financial analysis will tend to differ according to the nature of the project, we can infer from the Company Analyses the types of costs that these firms typically consider in project analysis. Table ES-1 presents an overview of the costs estimated in the Company Analyses and the TCA. The TCA column represents a complete set of known internal costs and revenues affected by the project. By comparing the Company Analysis column against the TCA column, a picture emerges of the firm's project costing approach.

Direct and Indirect Costs. Had a full financial analysis of the white water/fiber reuse project (Project 1) been done by the mill prior to this study, energy savings associated with reduced fresh and waste water pumping and treatment and freshwater heating would have been omitted. These energy savings, which are included in the TCA, represent a substantial benefit of the project. Their omission in a traditional financial analysis would have drastically underestimated the profitability of the investment.

In the case of Project 2, the Paper Coating firm omitted all non-disposal waste management costs, utilities (energy, water and sewerage), solvent recovery, and regulatory compliance costs from its analysis of the aqueous conversion project. The firm also omitted several costs associated with the storage needs and shorter shelf life of aqueous coatings, namely a steam heating system for the coating storage shed, lost raw material value, and the cost to dispose of spoiled coating.

Future Liability Costs. In this study we have focused on two general forms of future liability costs: liability from personal injury or property damage (e.g., Superfund liability stemming from a leaking landfill), and penalties and fines for violation of environmental regulations. In the case of Project 2, the Paper Coating firm did not include an estimate of avoided future liability costs owing to reduced hazardous waste disposal in their own financial analysis. They did, however, allude to this benefit in a qualitative way in their Appropriations Request: "...major reductions in levels of fugitive emissions, and amounts of solid hazardous waste going to landfill, is very positive from a regulatory and community standpoint". The TCA developed for this project includes an estimate of avoided future liability. Since Project 1 does not involve hazardous materials or waste, neither the Company Analysis nor the TCA contains a future liability estimate.

Less Tangible Benefits. Less tangible benefits from pollution prevention investments, such as increased revenue from enhanced product quality, company or product image, and

reduced worker health maintenance costs or productivity are certainly the most difficult to predict and quantify. Neither Company Analyses nor TCAs contain estimates of less tangible benefits. In the case of Project 2, the coated paper product is sold domestically, on the basis of cost, visual appearance, and performance durability, to book publishers and other intermediate product manufacturers. Although the company expects some quality improvements using aqueous coating, it does not anticipate an increase in market value. Therefore, it expects no increase in domestic sales as a result of the conversion to the aqueous/heavy metal-free coating. The company hopes to improve its competitive advantage in the European market if the European Economic Community implements lead-free packaging standards (which would apply to books) as expected. However, it would not speculate on the potential revenue effects associated with increased European market share.

The Coated/Fine Paper Mill does not expect an increase in market share or product value from its white water/fiber reuse project. Both the mills are manufacturers of intermediate, rather than consumer products, and cannot directly market their products on the basis of environmental performance in the way that a consumer products company like Procter and Gamble can and does.

A reduction in solvent use at the Paper Coating firm will certainly reduce worker exposure to fugitive solvent emissions, and the elimination of nitrocellulose from the coating mixture will reduce flammability and explosivity hazards. While reduced solvent exposure may result in a lower incidence of worker illness over the long-term, and the elimination of nitrocellulose may result in fewer worker injuries, we did not have adequate information to estimate the potential impact of these benefits on either the company's health care costs or long-term worker productivity. This issue was dealt with qualitatively in a section of an Appropriations Request, developed by the company, called "Safety/Health Impact of Converting from Solvent to Aqueous Coating", which listed specific project benefits that will improve safety and industrial hygiene.

Many company representatives noted that project benefits are more persuasive if they are monetized and included in the project financial analysis. However, when costs are difficult or impossible to monetize, a qualitative approach may be more credible with management.

Omitted non-environmental costs. In developing the TCAs for the two projects, we attempted to add to the Company Analyses any capital or operating costs or savings that could be attributed to the project and reasonably estimated. While our focus was on environmental costs typically omitted from project analyses, the process of developing a more comprehensive list of costs (or "casting the cost net wider") unearthed other, "non-environmental" costs that were not considered by the company. In the case of Project 2, all previous company analyses of the aqueous/heavy-metal free conversion had omitted the costs of heating system installation, the energy needed to prevent the aqueous coating from freezing, and the additional energy needed to dry aqueous versus solvent-based coating. While the latter cost was acknowledged by several production engineers and managers in meetings with Tellus, it had never been estimated nor included in previous analyses.

The effect of such costs on a project's financial performance depends upon whether the item represents a cost or a savings for the project. In the case of Projects 1 and 2, these non-environmental costs tended to increase the total cost of the project by adding to capital and operating costs. While this finding is probably not a surprise to those who prepare project analyses, *it is important to point out that the TCA process may reveal additional costs as well as savings for the project.* If the financial impact from the addition of regulatory compliance or waste management activities is marginal, they may be negated by the addition of one or two previously omitted non-environmental costs.

FINANCIAL INDICATORS

Financial indicators are a critical, though not exclusive, ingredient in justifying pollution prevention projects. Firms typically use such indicators as guideposts rather than decisive elements in judging the merits of a proposed project. Their application tends to be flexible, that is, subject to substantial management discretion as proposals move through the formal or informal budgeting process and compete against one another for scarce capital.

For the relatively large companies included in this study, payback (or the slightly more sophisticated ROI) is typically used as a first screen. If a project passes a prescribed hurdle rate, a more in-depth analysis that computes NPV and/or IRR is common. The Paper Coating Company uses ROI to screen proposed projects before subjecting them to more in-depth NPV and IRR analyses. The Fine/Coated Mill uses payback in a similar fashion. This practice provides the project proponent with an informal estimate of expected performance prior to investment of staff resources (and personal capital) in advocating a proposal. Once this milestone is passed, the proposal typically moves into a divisional or sectoral review where more complex calculations are developed to capture the longer-term costs/savings.

In none of these cases is the hurdle rate inflexibly applied. Instead, there are perceptions associated with each project that are defined by the project's place in the strategic thinking of top management and the degree to which outside pressures from customers, regulators, or the community are applied. In the case of the Coated Fine Paper Mill, the professed hurdle rate for projects is a 2 year payback. However, certain production-oriented projects have been implemented without meeting this rate, primarily because there was a general perception among decision-makers that these projects were needed to maintain productivity. On the other hand, discretionary environmental projects are more rigidly measured against the company's hurdle rate. This seems to be a result of an impression that environmental projects by nature are virtually always unprofitable.

To examine the effect of the choice of financial indicators and time horizon, we created two functional categories of indices: discounted cash flow methods that consider a stream of future cash flows for the investment (e.g. NPV and IRR), and one which does not (e.g. simple payback period).

TIME HORIZON

Time horizon, of course, is closely tied to financial indicators. Simple payback and ROI calculations are not capable of capturing long-term costs/savings, a particularly severe shortcoming in the case of liability estimation where benefits may materialize 10 years or more into a project's lifecycle. NPV and IRR, on the other hand, can account for costs and savings as they occur in future years. Their use is typically associated with large firms and large investments whose market and budgeting horizons are expansive, and who are able to wait many years for a stream of benefits to materialize.

In preparing the TCA for the Paper Coating Mill, managers indicated that a time horizon of 10 years is typical for major investments. The need for extending this figure to 15 years to capture the liability avoidance benefits became evident in preparing the TCA analysis; if the time horizon was less than 13 years, the liability estimate would not have been incorporated into the financial indicators. In the case of the Fine/Coated Paper Mill, once a discretionary project such as the white water/fiber reuse system passes an informal payback screening, it is subjected to a 10 year discounted cashflow analysis. Since the TCA for this project did not involve any costs (e.g. future liability costs) that would be incurred in the out-years, the time horizon is less critical to capturing the full financial impact of the project. In any case, the linkage between financial indicator, time horizon, and cost inclusion is a powerful rationale for promoting and practicing TCA in pollution prevention project analysis.

PROFITABILITY ANALYSIS

The comparative analyses for each project yield substantially different results. For Project 1, the white water and fiber reuse investment, the net present value (over 15 years) for this \$1.5 million capital expenditure shifts from \$0.36 million in the Company Analysis to \$2.85 million using a TCA approach; the internal rate of return (IRR) increased from 21% to 48%; and the simple payback of 4.2 years decreased to 1.6 years, well within the mill's 2-year payback rule of thumb. By excluding the savings associated with freshwater pumping, treatment, and heating, and waste water pumping, the Company Analysis makes the project appear substantially less profitable than it actually is.

Contrasting results are produced for Project 2, the aqueous conversion investment. NPV for this \$0.9 million capital expenditure shifts from -\$0.2 million to -\$0.4 million in the company versus TCA analyses, respectively; IRR shifts from 11% to 6%; and simple payback rises from 7.6 to 11.7 years. The inclusion of previously omitted savings for waste management, regulatory compliance, and future liability in the TCA are outweighed by the previously omitted utility costs. As a result, the TCA analysis illustrates that the proposed project is actually less profitable than originally thought. Nonetheless, the exercise achieves its ultimate goal - providing a clear, comprehensive picture of the investment option.

IMPLICATIONS

Analysis of this limited sample of two projects does not suggest that, *a priori*, more comprehensive treatment of project costs and savings necessarily yields higher performance for prevention investments. Much depends on the original capital cost of the project, the completeness of the company analysis, and the magnitude and timing of indirect and less tangible benefits. And, surprisingly, TCA is equally likely to turn up additional costs as well as additional savings, potentially diminishing the appeal of prevention investments. Moreover, the effort expended in preparing the TCA analysis, though partially attributable to startup costs of any new practice, is substantial enough to make even large firms wary of adopting such an approach for all projects competing for capital resources.

The limited number of cases examined here precludes generalizations about overall corporate receptivity to TCA approaches and the degree to which pollution prevention will be accelerated by its adoption. Within the limitations of our study, however, it is clear that TCA can serve as a valuable tool for translating discretionary judgments into concrete dollar values during the capital budgeting process. Insofar as pollution prevention projects produce less tangible and indirect costs and benefits, TCA equips managers to develop a more precise estimation of the real financial returns to such projects. Though TCA does not insure an attractive profitability level for prevention projects, the cost characteristics of such projects suggests that their financial performance in general will be enhanced by TCA. This is likely to be particularly true for industrial prevention projects that are materials and process-focused, that is, well upstream in the production process. Over the longer term, TCA can serve as a substantial force in recasting the "must-do" and "inherent loser" image of environmental projects into a more positive, profit-adding and market-expanding image.

Several approaches for promoting TCA in the context of EPA's pollution prevention strategy emerge from this study. In general, it is clear that moving firms to modify their analytical procedures requires a belief that TCA will produce a clearer picture of the profitability of prevention projects and thereby managerial decision-making. Thus, the primary goal of a promotion program should be to convince firms that TCA is **not** simply another regulatory mandate, but a vehicle for rationalizing their internal capital budgeting process.

More concretely, EPA has already worked to promote TCA by developing the *Pollution Prevention Benefits Manual*, the *Waste Minimization Opportunity Assessment Manual*, and sponsoring the initial work on PRECOSIS, all of which contain discussions of TCA concepts and provide analytical tools. Further efforts to disseminate more widely these and other tools such as **P2/FINANCE**, a tool developed for this study, will accelerate the advancement of the TCA concept. Published case studies which use a TCA approach to project financial analysis could be a valuable supplement to past initiatives.

At the state level, TCA may be built into pollution prevention policies and programs in several ways. State technical assistance programs may offer TCA guidance and training as a complement to their technical services, by providing TCA training seminars, with specialized

modules aimed at large versus small firms, or for firms in certain lines of business. A number of states have instituted requirements for industry to develop pollution prevention plans that must contain technical and economic feasibility assessments of specific prevention projects. The New Jersey Pollution Prevention Act, for example, explicitly requires that plans include a comprehensive analysis of the costs associated with the use, generation, release or discharge of hazardous substances for current production processes and the savings realized by investments in pollution prevention. *Planning for Success Through Waste Reduction*, the planning guidance document created by the Washington State Department of Ecology under the State's Hazardous Waste Reduction Act, instructs companies to evaluate the costs and benefits of selected waste reduction options over a five year period. It also requires firms to describe the accounting systems used to track hazardous substance and waste management costs which must include "liability, compliance, and oversight costs".

Requiring a TCA approach in pollution prevention planning may direct firms to incorporate unconventional cost items and/or longer time horizons to enhance the competitiveness of prevention investments. The long-term effectiveness of this approach, however, is unproven and should be approached cautiously and with a strong emphasis on the company self-interest alluded to earlier. While rigid, prescriptive approaches are undesirable, some type of standard could facilitate the implementation of emerging federal and state regulations requiring TCA in pollution prevention planning.

The limited sample size of firms in this study allows for only indicative findings that must be corroborated by the analysis of additional cases. Existing TCA methods have been available for several years, yet no systematic assessment of user experience among the several hundred purchasers of various systems is available. This presents a potentially rich data base for further assessing the organizational and economic issues in TCA adoption which we uncovered in this study.

Quantifying the benefits of green technologies, green products and green corporate image remains a major challenge. It is precisely these benefits that are heard by corporate managers as reasons for approving otherwise marginal projects. Developing methodologies to quantify these benefits and incorporate them into project financial analysis is an unfinished task.

Finally, what is financially optimal for the firm, of course, is not necessarily optimal from a social cost standpoint. In this sense, TCA is no substitute for lifecycle assessment (LCA), in which the choice of a material input or the manufacture of a product is assessed for its full *societal costs* regardless of whether they fall within or outside the purview of the firm.

Table ES-1 Overview of Cost Inclusion by Company and TCA for Projects 1 and 2

X = Cost(s) Included

P = Cost(s) Partially Included

	Project 1 ¹		Project 2 ²	
	Company	TCA	Company	TCA
Capital Costs				
Purchased Equipment	X	X	X	X
Materials (e.g. Piping, Elec.)	X	X		
Utility Systems	X	X		X
Site Preparation	X	X		
Installation	X	X		
Engineering/Contractor	X	X	X	X
Start-up/Training			X	X
Contingency	X	X		
Permitting				
Initial Chemicals				
Working Capital				
Salvage Value				
Operating Costs				
<u>Direct Costs:</u> ³				
Raw Materials/Supplies	P	X	P	X
Waste Disposal			P	X
Labor	X	X	X	X
Revenues - General				
Revenues - By-products				
Other:				
Transportation				
<u>Indirect Costs:</u> ⁴				
Waste Management				
Hauling				X
Storage				X
Handling				X
Waste-end Fees/Taxes				X
Hauling Insurance				
Utilities				
Energy	P	X		X
Water		X		X
Sewerage (POTW)	X	X		X
Pollution Control/Solvent Recovery				X
Regulatory Compliance				X
Insurance				
Future Liability				X

Notes:

1. White water/fiber reuse project
2. Solvent/heavy-metal to aqueous/heavy metal-free coating conversion
3. We use the term "direct costs" here to mean costs that are typically allocated to a product or process line (i.e. not charged to an overhead account) and are typically included in project financial analysis.
4. We use the term "indirect costs" here to mean cost that are typically charged to an overhead account and typically not included in project financial analysis.

Table ES-2 Summary of Financial Data for Project 1 - White Water and Fiber Reuse Project

	<u>Company Analysis</u>	<u>TCA</u>
Total Capital Costs	\$1,469,404	\$1,469,404
Annual Savings (BIT)*	\$ 350,670	\$ 911,240
<u>Financial Indicators</u>		
Net Present Value - Years 1-10	\$ 47,696	\$2,073,607
Net Present Value - Years 1-15	\$ 360,301	\$2,851,834
Internal Rate of Return - Years 1-10	17%	46%
Internal Rate of Return - Years 1-15	21%	48%
Simple Payback (years)	4.2	1.6

* Annual operating cash flow before interest and taxes

Table ES-3 Summary of Financial Data for Project 2 - Aqueous/Heavy Metal Conversion Project

	<u>Company Analysis</u>	<u>TCA</u>
Total Capital Costs	\$893,449	\$923,449
Annual Savings (BIT)*	\$118,112	\$ 79,127
<u>Financial Indicator</u>		
Net Present Value - Years 1-10	(\$314,719)	(\$480,512)
Net Present Value - Years 1-15	(\$203,643)	(\$395,625)
Internal Rate of Return - Years 1-10	6%	0%
Internal Rate of Return - Years 1-15	11%	6%
Simple Payback (years)	7.6	11.7

* Annual operating cash flow before interest and taxes